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PROCEEDINGS OF THE 5TH INTERNATIONAL BETATRON SYMPOSIUM

(Selected Articles)

FOREIGN TECHNOLOGY DIVISION

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U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*<u>ye</u> initially, after vowels, and after ъ, ь; <u>e</u> elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$sinh^{-1}$
cos	cos	ch	cosh	arc ch	$cosh^{-1}$
tg	tan	th	tanh	arc th	$tanh^{-1}$
ctg	cot	cth	coth	arc cth	$coth^{-1}$
sec	sec	sch	sech	arc sch	$sech^{-1}$
cosec	csc	csch	csch	arc csch	$csch^{-1}$

Russian	English
rot	curl
lg	log

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SOME RESULTS OF THE INVESTIGATICN CF THE PROCESS OF ACCELERATING ELECTRONS IN A HIGH-CURRENT BETATRON.

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In the process of operating the high-current betatron on 25 MeV [1] it was established/installed, that during tuning of accelerator to the maximum intensity of radiation/emission during the cycle of acceleration begin to appear the electromagnetic waves of high frequency. With this was simultaneously noticed an increase in the instability of the intensity of radiation/emission at the output of accelerator. In connection with this were carried out the investigations and the measurements of the parameters of this radiation/emission for the purpose of the explanation of its connection/communication with the process of the electron beam

acceleration. In this article are given the results of these investigations.

The measurement of the parameters of HF fields, generated in the process of acceleration, was carried out in the range from 15 MHz to 300 MHz. Reproduction of the entire band of frequencies was accomplished with the aid of the wideband amplifier, and the measurement of frequencies by measuring receiver. As the sensors HF fields were utilized both the broadband antenna, arranged/located outside the accelerative chamber/camera, and the probe, placed within the chamber/camera. To registering apparatus the signals from the antenna and the probe were supplied on coaxial cable with the matched load. As a result of measurements was established/installed the following.

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Electromagnetic radiation carries discrete/digital character and appears only during some intervals of the cycle of the accelerations whose duration can be 10-300 μs. Characteristic form of HF signals after their amplification and detection is given in Fig. 1.

Is here reproduced entire cycle of the acceleration whose duration 5000 μs. In the beginning and at the end of the cycle are visible

noise signals from the systems cf injection and bias of electrons from the orbit, while in tho gap/interval between them envelcpe HF signals. In this cycle a rumber cf generated impulses/momenta/pulses of radio emission is equal tc six. From one cycle to the next the moment/torque of generaticn, the amplitude and a number of impulses/momenta/pulses cf radic emission can somewhat change.

The measurement of the spectral composition of the generatable impulses/momenta/pulses with the aid of the measuring receivers, showed that in each of them are ccntained the frequencies, which lie at the following ranges: 47-51 MHz, 53-55 MHz, 91-101 MHz, 103-109 MHz. In this case the medium frequencies of the first two ranges are approximately two times less than the corresponding to them frequencies of the follcwing ranges.

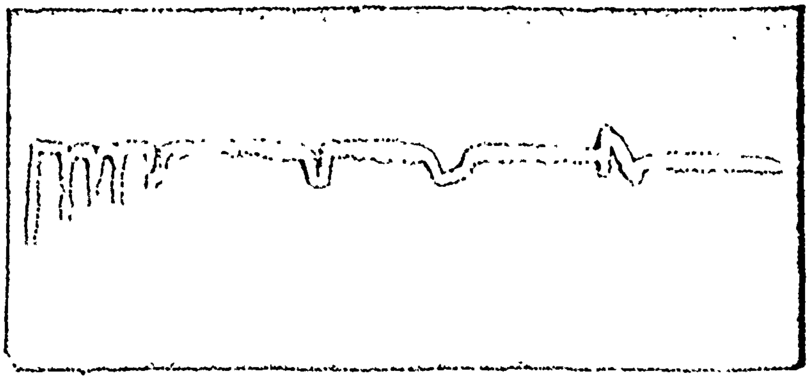

Fig. 1. Oscillogram of HF frequency signal amplitude envelope which appear in the process of the electron beam acceleration in the high-current betatron cn 25 MeV.

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From the measurements it was established/installed, that the average/mean intensity/strength of HF field within the accelerative chamber/camera comprises at frequencies of 47-51 MHz and 53-55 MHz ~10 of mV/m, and at frequencies of 96-101 MHz and 103-109 MHz of ~1 mV/m. This it indicates that the medium frequencies of the first two ranges are basic, and two others correspond to the second harmonics of fundamental frequencies. In all other sections of the range being investigated radio emission it was not discovered.

The possible reasons for the generation of HF fields with such

frequencies can be coherent oscillations of particles in the beam, caused by the final conductivity of surrounding walls, and also excitation of the accelerative chamber/camera at the natural frequencies, which performs in this case the role of the locked waveguide. Amplitude and number of impulses/momenta/pulses of radio emission strongly depend on the current strength in orbit. The excitation of fields at the frequencies indicated in the accelerative doughnut begins only with the specific magnitude of the charge of that trapped into acceleration. In this case is generated only one first impulse/momentum/pulse (250-300 μs after the end of the process of injection) and its amplitude is very small. Further increase in the seized charge at first leads to a proportional increase in the first impulse/momentum/pulse and to the emergence of the subsequent impulses/momenta/pulses. The value of the accelerated charge (intensity in the impulse/momentum/pulse) in this case also increases. But then with some values of the seized into the accelerations charge and amplitude of first pulse of radio emission begins a reduction in the value of the accelerated charge. This means that the process of the generation of first pulse of the radio emission whose amplitude almost is always more than the subsequent impulses/momenta/pulses, at this value of current in orbit is accompanied by the loss of the part of the accelerated charge. Such losses of charge were recorded with the aid of the photomultiplier, placed near the accelerative chamber/camera. Since the amplitude of

first pulse of radio emission from one cycle to the next varies near the threshold value, the stability of the pulse intensity of radiation/emission in this mode of operation of betatron substantially descends.

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The degree of the effect of different parameters and, including amplitude of first pulse of radio emission on the stability of the pulse intensity of radiation/emission was determined via the simultaneous recording of the random fluctuations of these parameters and comparison of their numerical values in relative unity [2]. For this purpose was developed the special equipment, which makes it possible produce simultaneous recording to 8 parameters of betatron. Fig. 2 depicts the part of the combined recording of five parameters of betatron.

Here downward are arranged/located the voltage oscillograms on magnet Um, the phases of injection ti, voltage of the pulse of injection Ui, voltage of injection pulse and intensity of radiation/emission $\mathcal{J}_{\gamma}$.

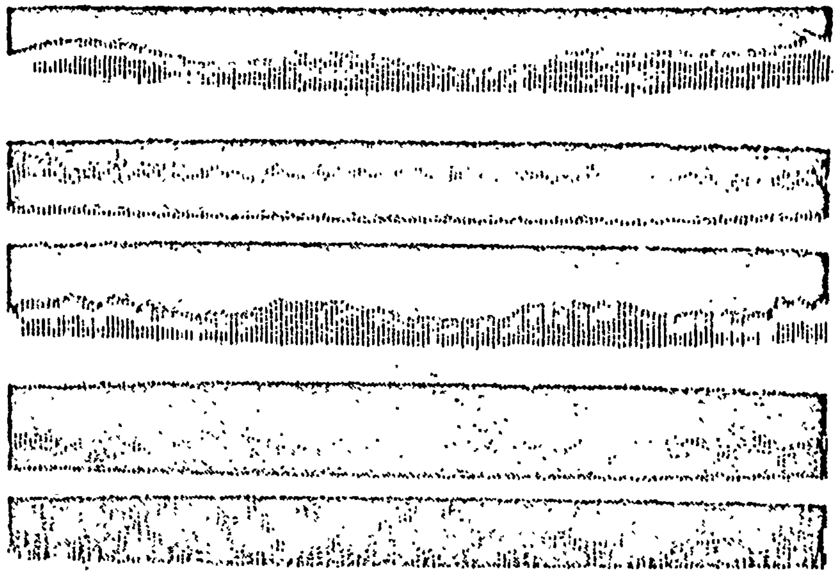

Fig. 2. The part of the oscillogram of the combined recording of the oscillations of the parameters of the betatron (in the oscillogram are reproduced not full/total/complete signal amplitudes, but their only upper, oscillating part).

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According to obtained numerical data of recording were constructed the systematized correlation fields and the tables, which show scattering the random fluctuations of one parameter at a change in another.

Such fields and tables were constructed for all possible paired

combinations of the measured parameters and according to them were calculated the estimations of pair correlation.

The calculated characteristics of correlation showed that the fluctuations of the pulse intensity of radiation/emission J_{γ} are weakly correlated with the oscillations of parameters Um, ti, Ui and Uf. The scatter of the values of data of the parameters is such, that it leads only to 4o/o of instability J_{γ}. While root-mean-square of scattering the fluctuations of pulse intensity it is equal to 28o/o.

As a result of processing the combined recording of random fluctuations J_{γ} and amplitude of first pulse of radio emission ($U_{в.ч.}$) it was established/installed, that oscillations J_{γ} are strongly correlated with oscillations $U_{в.ч.}$. The approximation of empirical regression line by linear first-order equation made possible to compose by the method of least squares the equation, which connects the amplitude of first pulse of radio emission (in the millivolts) and relative change in the intensity of radiation/emission from its maximally possible level (in the percentages).

$$\Delta J_{\gamma} = -24 + 0{,}126\, U_{в.ч.} \qquad (1)$$

Equation (1) is correct, when the amplitude of HF signal is higher than the threshold value. This value for the probe used is equal to 190 mV. The maximum observed amplitude of HF signal in our

experiments does not exceed 370 mV. The substitution of this value in (1) gives the relative instability of intensity 23o/o.

Thus, it was established/installed, that the instability of the pulse intensity of radiation/emission in the investigated mode/conditions of work of the accelerator is weakly connected with the fluctuations of the seized current and is determined by the processes, which develop in the electron beam after injection with the excess of the specific level of the seized current.

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The development of these processes according to the power from the cycle to the cycle of acceleration carries noise character; therefore the pulse intensity of radiation/emission is not correlated from one impulse/momentum/pulse to the next and it cannot be stabilized at the maximum level with the aid of at present the methods of stabilization used.

For increasing the operational stability of accelerator in the mode/conditions of peak output, is conducted the supplementary investigation of the process of acceleration and are developed/processed measures for the stabilization of this process.

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OUTPUT OF ELECTRON BEAM FROM THE ACCELERATIVE CHAMBER OF HIGH-CURRENT BETATRON BY PULSE SINGLE-THREAD AND ELECTROSTATIC METHODS.

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The successes of recent years in an increase in the intensity of radiation/emission frcm betatron (1) made this accelerator even more promising both for the scientific cres and for the practical uses/applications.

During development and operation of high-current betatrons as all other accelerators, by very important is a question about the economical utilization of the accelerated beam of particles. By the solution cf this questicn are represented two basic possibilities: the use of bremsstrahlung or cf the electron beam, brought cut from the accelerative chamber/camera in the atmosphere.

In all prepared, until now, by us high-current betatrons was applied thus far only first possibility. However, both for the

scientific investigations and for the use/application in the production targets necessary are the intense electron beam, brought out from the accelerative chamber/camera of high-current betatron. In connection with this was set the task in the beam extraction of electrons from the accelerative chamber/camera of the high-current of betatrons in the atmosphere.

The conclusion of the accelerated electron beam and betatrons is conducted by different methods; however, many of them proved to be unsuitable for the use/application to the high-current betatrons, which have the series/row of design features (increased interpolar clearance, the injection of electrons with the aid of the inflector plates, strongly deepened in the accelerative chamber/camera and located in the plane of equilibrium orbit, large radial size/dimension from the equilibrium orbit to the boundary of the region of radial stability and to the external chamber wall).

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These design features, and also high current of beam lead to the considerable difficulties in the realization of the conclusion/output of electrons from the chamber/camera and in the investigation of the parameters of emitted beam.

Analysis and calculation of the methods of beam extraction from the cyclic electron accelerators made it possible to conclude that a conclusion of electrons from the high-current betatron can be carried out into two stages:

a) the preliminary slow expansion of orbit to a radius, somewhat smaller radius of the arrangement/position of the internal plate of inflector;

b) the conclusion/output of electrons from the accelerative chamber/camera from the preliminarily expanded orbit.

The preliminary slow expansion of orbit is conducted with the aid of the winding, arranged/located on the central core. For the supply of expansion winding is utilized the pulse generator of current with an amplitude of up to 2000 A; the pulse duration - 280 μs. From the preliminarily expanded orbit the beam extraction was realized by electrostatic and pulse single-thread by methods.

The pulse magnetic deflector, with the aid of which is realized single-turn beam extraction, consists of two short-circuited line, one of which is arranged/located above median surface of accelerator, another - is below. The lines of deflector are prepared from the plates of the stainless steel with a thickness of 1.2 mm. The

azimuthal extent of deflector compose' 44°. The axial size/dimension of deflector is equal - 8.5 cm, radial - 6 cm. Azimuthal angle between the center of leading-cut window and the deflector - about 130°.

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The supply of deflector is realized from the high-voltage oscillator of nanosecond impulses/momenta/pulses. Fundamental oscillator circuit is given in Fig. 1.

As the commutator is applied trigatron type gas-filled discharger/gap, distinctive special feature/peculiarity of which is the trigger electrode, made in the form of the toroid, located near cathode. Trigger electrode virtually is not charred, since through it does not pass operating current. As filler is utilized capacitor bank Cy by a capacity/capacitance $5 \cdot 10^{-9}$ F, collected from the capacitors/condensers of the type K 15-4. The charge of capacitor bank is realized from the half-wave single-phase rectifier, made on the semiconductor devices of the type D 1006. The pulse duration on the load (deflector) is determined by the length of the forming line L_1, which is the coaxial line, prepared from the brass ducts and filled with transformer oil. For obtaining the steep-sided pulse is utilized the peaking discharger/gap R_2, connected between the forming

and transmission lines. The commutating and peaking dischargers/gaps are filled with nitrogen under the pressure 15 atm. Transmission line L_2 as forming, is made in the form of coaxial construction/design. The line characteristic and deflector is equal to 25 ohms.

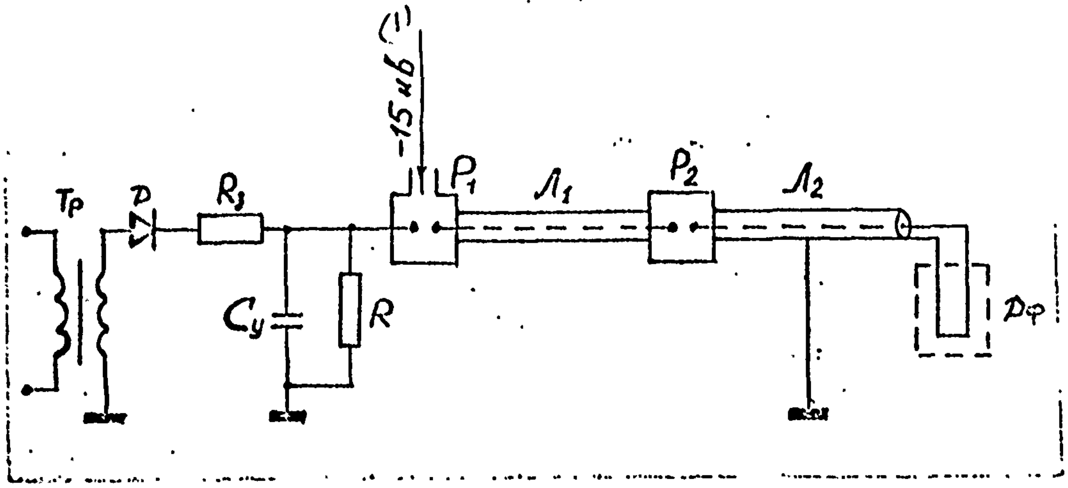

Fig. 1. Schematic diagram of the high-voltage oscillator of nanosecond impulses/momenta/pulses.

Key: (1). kV.

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Into forming and transmission lines are installed the capacitive voltage-dividers, intended for the connection of oscillograph.

Oscillator makes it possible to obtain on the deflector impulses/momenta/pulses in amplitude to 100 kV, by the duration of 13-15 ns and by rise time of pulse edge - 1-2 ns.

With the aid of the described devices/equipment from the accelerative chamber/camera of high-current betatron is brought out the electron beam whose parameters are given in Table 1.

The electrostatic method of conclusion/output is realized with the aid of the capacitor/condenser of special construction/design. For the supply of capacitor/condenser is prepared the pulse generator of voltage with the following parameters: the amplitude of pulse of voltage - 100 kV; the pulse duration - 3 μs; the duration of pulse edge - 0.5 μs.

Table 1. Parameters of the electrcn beam, brought out by pulse single-thread method.

(1) максимальная кинетическая энергия электронов	25 (2) Мэв
(3) число электронов в импульсе (4) около	$1{,}5\cdot10^{11}$
(5) длительность импульса излучения	5 – 6 (5a) нсек
(6) средний ток пучка за длительное время работы (при частоте повторения импульсов 25 гц)	0,6 мка (6a)
(7) ток пучка в импульсе	4,8 а
(8) размеры пучка у выводного окна:	
(9) а/горизонтальный	6 см
(10) б/вертикальный	1,8 см
(11) угловая расходимость пучка:	
(12) а/ в горизонтальном направлении	2^{0}
(13) б/ в вертикальном направлении	1^{0}
(14) линейная длина электронного сгустка	1,5–1,8 м

Key: (1). maximum kinetic energy cf electrons. (2). MeV. (3). number of electrons in impulse/mcmentum/pulse. (4). about. (5). duration of pulse of radiation/emissicn. (5a). ns. (6). average/mean beam current for long operating time (at pulse repetition frequency 25 Hz). (6a). μA. (7). beam current in impulse/momentum/pulse. (8). sizes/dimensions of beam in leading-cut window. (9). horizontal. (10). vertical. (11). angular divergence of beam. (12). in hcrizontal direction. (13). in vertical direction. (14). linear length cf

electronic cluster.

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The parameters of electrcn beam are given in Table 2.

Thus, utilizing one or the other methods of the beam extraction of electrons from the high-current betatron, it is possible tc obtain electron beams by the duration cf the order of nanoseconds or microseconds.

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Table 2. Parameters of electrcn beam, brought out by electrostatic method.

(1) максимальная кинетическая энергия электронов		25 Мэв (2)
(3) число электронов в импульсе	(4) около	$8 \cdot 10^{10}$
(5) длительность импульса излучения	(4) около	1 мксек (6)
(7) средний ток пучка (при частоте повторения импульсов 50 гц)		0,34 мка (8)
(9) ток пучка в импульсе		12,8 ма (10)
(11) размеры пучка у выводного окна		3x1,5 см^2
(12) угловая расходимость пучка	(4) около	10°

Key: (1). maximum kinetic energy of electrons. (2). MeV. (3). number of electrons in impulse/momentum/pulse. (4). about. (5). duration of emission impulse. (6). μs. (7). average/mean beam current (at pulse repetition frequency 50 Hz. (8). μA. (9). beam current in impulse/momentum/pulse. (10). mA. (11). sizes/dimensions of beam in leading-out window. (12). angular divergence of beam.

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ELECTROMAGNET OF COMPACT HIGH-CURRENT BETATRON ON 25 MeV.

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Developed in NII YaF by Tomsk polytechnic institute the constructions/designs of high-current betatrons [1, 2, 3] possess relatively larger overall dimensions and weight, and consume a considerable quantity electric power. The facts indicated are caused by the fact that during the design of high-current betatrons the primary attention was given to a maximum increase in the number of accelerated particles per pulse, but by a question of a reduction in weight and overall sizes of special attention it was not given. In connection with this in the series/row of scientific conferences, including on the international symposium on the betatrons in 1966, were noted the high parameters of the beam of the accelerated electrons, but it is indicated, that the large weight of emitter is the essential deficiency/lack, which limits the possibility of applying the high-current betatrons in industry and flaw detections.

Taking into account that stated above, we during the design of the new version of high-current betatron attempted to maximally facilitate its weight, utilizing for this weight possible and available to us methods.

1. It is known that weight of steel of electromagnet of accelerator of type of betatron in the first approximation, varies in proportion to of cube of radius of equilibrium orbit τ_0. Therefore decrease τ_0 gives into the most perceptible gain in the weight. But for decrease τ_0 it is necessary to increase induction in the central core.

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All high-current betatrons TPI, just as other types of Tomsk induction accelerators, they are prepared their cold-rolled steel E-330, which has the maximum induction (near the saturated region) along the direction of rolling equal to 1.8 T. At present is discharged the cold-rolled strip from the alloy of the type "peremendyur" 49KF-VI (EP-581) and K50F2. With the magnetic intensity H=25 A/cm the saturation induction of alloy EP-581 is equal to 2.2 T. The curve of magnetization of alloy EP-581 is given in Fig. 1. Is here for the comparison given the analogous characteristic of transformer steel E-330. The use of an alloy EP-581 instead of steel

E-330 as the material of central core made it possible 1.3 times to increase induction in the center, to decrease Z_0 and to considerably lower the weight of magnetic circuit.

2. In usual betatrons material of poles is not utilized completely, and, as a consequence of this, descends efficiency/cost-effectiveness of installation. Tendency toward rays/beams to loading poles brought and to the production of poles with the "deflectors" (by projections) and to the development of poles with radial-latticed structure of shaped surface [4]. Together with certain reduction of weight in the first case decrease the radial sizes/dimensions of winding, the secondly - increases the cooling surface of pole. From the point of view of minimum weight best is the version of the magnetic circuit whose section is shown in Fig. 2. However, this construction/design is not technologically effective in the production and the assembly and does not consider the coincidence of lines of force with the direction of rolling. The developed by us construction/design of electromagnet, represented in Fig. 3b, is free from these deficiencies/lacks. Magnetic circuit six-stand without the clearly expressed poles, the shaped part smoothly converts/transfers into the frameworks. Section yoke in a radius increases in accordance with a change in the magnetic flux. The profile/airfoil of interpolar space provides the increase of "n" on a radius in conformity [5]. During capture in the acceleration of

more than 10^{12} particles the cperating point cf betatron proves tc be shifted for the area of action cf summation resonances.

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When $n(z) =$ var the conditions fcr the resonance in entire operating region are not satisfied, and linear and anharmonic resonances, through which passes the operating point of accelerator, is not exerted a substantial influence on the losses of particles [6]. The calculations of the magnetic fluxes, which are closed through the frameworks, carried cut employing procedure [7], and their estimation on the model, shcwed that the leakage flux composes 60o/o of the basis and dces nct exceed leakage fluxes (flow from the lateral surfacos of pole and the flcw, the filo closer through the framework) the betatrcn, prepared in the usual version.

3. Induction in steel yoke alsc of struts usually is selected on the basis of thermal conditicn cf wcrk and comprises during use/application of forced ventilaticn 1.4-1.6 T. The supply of electromagnet KBS is realized frcm the diagram with the pulse introduction/input of energy intc the outline, analogous to that described in [8]. The use/applicaticn of a pulse supply made it possible to increase inducticn in steel to 1.8 T during the natural cooling, to lower the weight cf the condenser/capacitor of batteries,

due to the porosity to decrease the sizes/dimensions of window for positioning/arranging the magnetizing coil.

Fundamental design characteristics of compact high-current betatron (KBS) are given in Table 1. Are here for the comparison given the parameters of the acting high-current betatron on 25 MeV [1]. Fig. 3 depicts electromagnets BS-3 and KBS in as identical scale.

As can be seen from table, the weight of active steel of electromagnet KBS 4.8 times more easily of the weight of steel BS-3. The role of different factors in a reduction in the weight of electromagnet KBS in comparison with the betatron on 25 MeV [1] is given in Table 2.

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Table 1. Comparison of the parameters of betatrons BS-3 and KBS.

№ № (a) п/п	(b) Параметры	КБС	БС-3
I	Максимальная энергия ускоренных электронов, Мэв	25	25
2	Ускоренный заряд (частиц в импульсе)	$1{,}2 \cdot 10^{12}$	$2 \cdot 10^{12}$
3	Напряжённость магнитного поля на орбите, тл	0,474	0,352
4	Индукция в материале центрального сердечника, тл	2,2	I,8
5	Число циклов ускорения в секунду	50	50
6	Радиус равновесной орбиты, см	I8,5	27,0
7	Зазор на радиусе равновесной орбиты, см	I4,5	25,0
8	Коэффициент спада магнитного поля на радиус равновесной орбиты	0,56	0,6
9	Площадь захвата, $см^2$	I00	I76
I0	Напряжение инжекции, кв	200	200-250
II	Вес активной стали, кг	I700	8200
I2	Габаритные размеры, см	ϕ=I55, h=72	234xI74xI30
I3	Охлаждение	(14) естественное воздушное	(15) принудительное воздушное

Key: (a). No No in sequence. (b). Parameters. (1). Maximum energy of acceleration of electrons, MeV. (2). Accelerated charge (particles per pulse). (3). Magnetic intensity in orbit, T. (4). Induction in

material of central core, T. (5). Number of cycles of acceleration per seccnd. (6). Radius cf equilibrium orbit, cm (7). Clearance on radius of equilibrium ~~they are upholstered~~ orbit, cm (8). Coefficient of decrease in magnetic field tc radius of equilibrium they are upholstered. (9). Area cf capture, cm². (10). Vcltage of injection, kV. (11). Weight of active steel, kg. (12). Overall dimensions, cm (13). Cooling. (14). natural air. (15). fcrced air.

Table 2.

№ № п/п (a)	(b) Использованные пути снижения веса электромагнита	(c) Уменьшение веса в %	(d) Уменьшение веса в кг по сравнению с БС-3 [1]
I	2	3	4
I	Увеличение индукции в центральном сердечнике с 1,8 тл до 2,2 тл	60	4900
2	Применение шестистоечной конструкции магнитопровода вместо Ш-образной	I8	590
3	Уменьшение расстояния между намагничивающими обмотками до размеров, достаточных для размещения инжектора на 200 кв и вывода электронов	I6	430
4	Применение новой конструкции магнитопровода в сравнении с обычной шестистоечной	I3,5	3I0
5	Применение импульсного униполярного питания вместо питания от сети промышленной частоты	I2	270

Key: (a). No No in sequence. (b). Used ways of reducing weight of electromagnet. (c). Reduction of weight in %. (d). Reduction of weight in kg in comparison with BS-3 [1]. (1). Increase of induction in central core with 1.8 T to 2.2 T. (2). Use/application of six-stand magnetic structure instead of w-shaped. (3). Decrease of

distance between magnetizing coils of sizes/dimensions, sufficient for positioning/arranging injector on 200 kV and conclusion/output of electrons. (4). Use/application of new magnetic structure in comparison with usual six-stand. (5). Use/application of pulse unipolar supply instead of supply from network/grid of industrial frequency.

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CONSTRUCTION OF ELECTROMAGNET.

Compact high-current betatron is designed in the six-stand version (Fig. 3b). The shaped part of working clearance (3) and framework (4) magnetic circuits represent unit, plates are chopped on one die/stamp of steel E-330 with a thickness of 0.35 mm. Induction from steel is accepted equal to 1.8 T. Frameworks have an inclination/slope of 30° to the median plane, the section yoke growing/rising with an increase in the radius. The joint of magnetic circuit is realized on the median plane. As intersheet insulation/isolation is used the glue BF. Frameworks and struts are confined by stud bolts with the aid of necks and for guaranteeing the solidity are baked. The assembly of magnetic circuit is realized in the special mold.

In the poles there are ground openings/apertures for central cores (1) which are fulfilled from the alloy EP-581 (is provided the use/application of the strip/film with a thickness of 0.2 mm). Induction in the alloy is accepted equal to 2.2 T. In view of the fact that the alloy possesses large magnetostriction; intersheet insulation/isolation of plates and taking them into the blocks/modules/units it is realized on special technology. The form of the center section of air gap of electromagnet is selected without pancake coils, with the taper, it is analogous with that described in [9]. Magnetizing coils (5) for the purpose of the decrease of heating by eddy currents, are coiled by a circular patch cord of the type "Litzendraht wire" by overall section throughout copper 185 mm².

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Coils frame-less, are coiled in the special form on 38 turns in each, and they are confined with the aid of the insulating planks.

In free space (2) between magnetic circuit and mounting plates are placed the thyristor diagrams of the supply of electromagnet and displacement.

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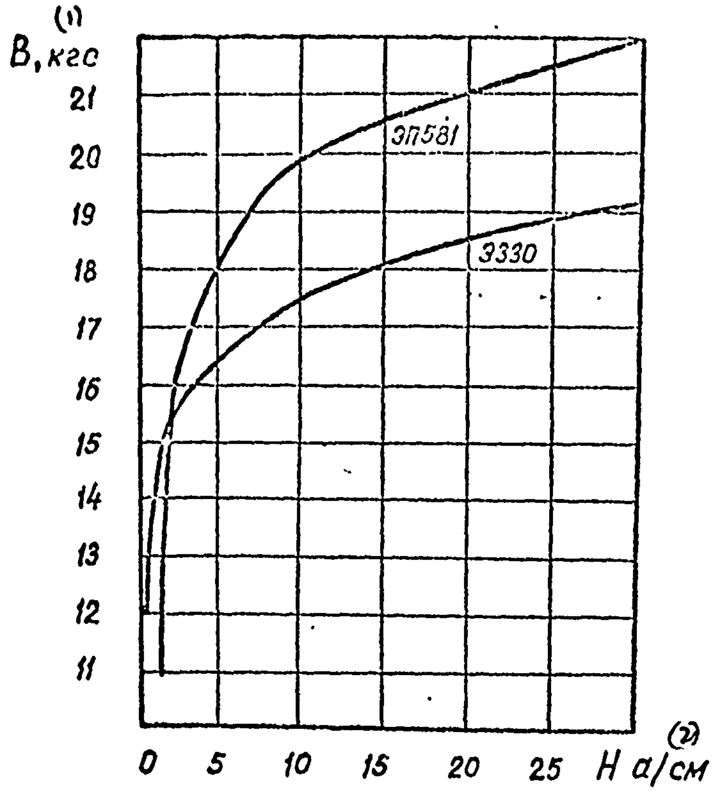

Fig. 1.

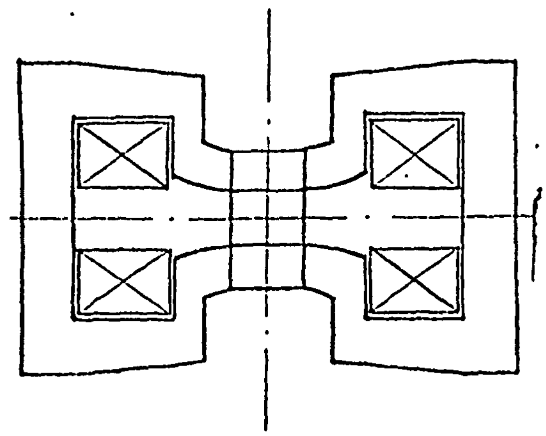

Fig. 2.

Fig. 1.

Key: (1). In, kg. (2). A/cm.

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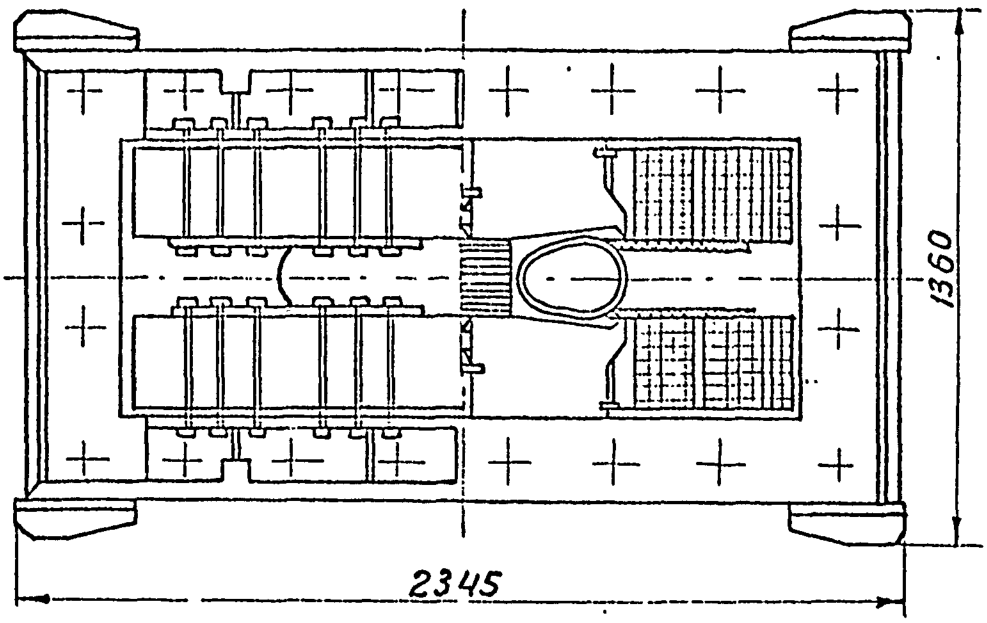

Fig. 3a.

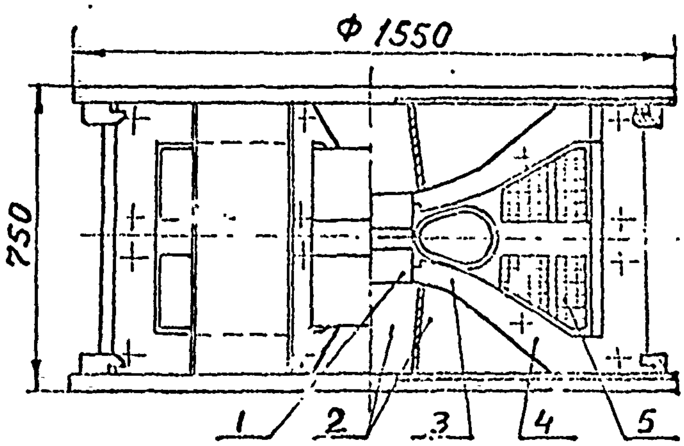

Fig. 3b.